THE

OPENING EXERCISES

OF THE

INSTITUTE OF HYGIENE

OF THE

UNIVERSITY OF PENNSYLVANIA.

PHILADELPHIA, FEBRUARY 22, 1892.

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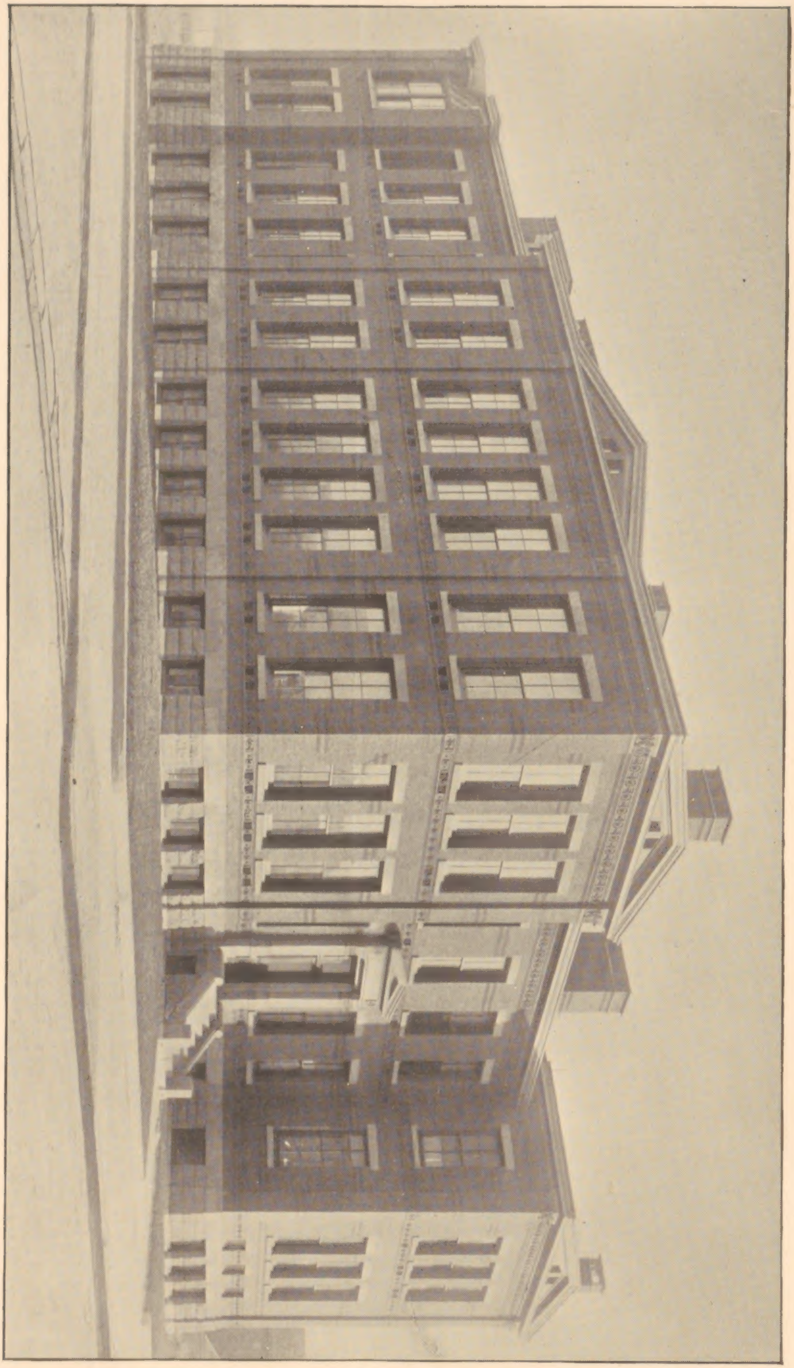

INTRODUCTION.

THE Institute of Hygiene of the University of Pennsylvania, the Laboratory building for which was the gift of Mr. Henry Charles Lea, of Philadelphia, was formally opened on February 22, 1892, at half-past three in the afternoon. The ceremonies, which were held in the Library of the University, were as follows:

Prayer—By the REV. DR. GEORGE DANA BOARDMAN.

Presentation of the new building to the Provost and Trustees. DR. S. WEIR MITCHELL, Chairman of the Committee on Hygiene.

Acceptance on behalf of the Provost and Trustees. PROVOST WILLIAM PEPPER.

Address—DR. BENJAMIN LEE, Secretary of the State Board of Health.

Address—DR. JOHN S. BILLINGS, Director of the Institute.

Address—DR. H. P. WALCOTT, President of the Massachusetts State Board of Health.

After the exercises the Laboratory was opened for public inspection.

WITH THE COMPLIMENTS

OF

J. S. BILLINGS,

Surgeon, U. S. Army.

CONTENTS.

ADDRESS OF S. WEIR MITCHELL, M.D.,

IN TRANSFERRING TO THE UNIVERSITY OF PENNSYLVANIA FOR HENRY CHARLES LEA, HIS GIFT OF THE BUILDING FOR THE INSTITUTE AND LABORATORY OF HYGIENE.

MR. PROVOST, TRUSTEES, GENTLEMEN, AND LADIES: I appear before you to-day officially as Chairman of the Committee on Hygiene of the University of Pennsylvania. I am here, also, to represent my friend, Henry Charles Lea, that I may make over to the Trustees the completed Laboratory, which he has built for the teaching and study of hygiene.

This, my very pleasant task, shall be brief. I am about, Mr. Provost, to give you another man's gift. For the moment, I am the owner. A faint, a subtile sense of the joy of being able, aye, more, of being willing to give on a scale so royal comes to me as I think of what I am about to do. I realize the honest joy such bounty brings to him who gives. I assure you that it fills me with an ardent, a philanthropic desire that more of you should share the delight of liberal giving to this ancient school of learning.

All that I might say as to the need for teaching and research in hygiene will be better said to-day by experts in this art and in the sciences which justify its precepts. But, as a physician, I am strongly moved to use this rare opportunity to preach a brief medical sermon. My text is taken from the first chapter and the first verse of a late writer on hygiene: "Hygiene aims to make growth more perfect, life more vigorous, decay less rapid, death more remote."

To this rather material statement I would add another: The highest usefulness in life is only possible with the highest standard of health. I no longer wonder that the ancients

worshipped *Health*, the fair goddess Hygeia. Be pleased to observe that this was a feminine deity, a goddess of health. The fact is not without meaning. So great is my reverence for supreme wholesomeness, that I should almost be tempted to assert, that perfect health is virtue. At least, as a physician, I like to say that, in my opinion, and for men in general, health, the best health, is essential to the attainment of that efficiency which makes duties easy, and resistance to temptation a normal result.

Speaking of the higher, the spiritual development of man's faculties, a famous divine has said: "Yes, it is a good thing to be born again, but he who wins this new birth will be better born again for having first been well born." The truth, the largely applicative truth of this epigram, comes home to every physician who has seen how much of the usefulness of the good, and the productiveness of the intellectual, is crippled or lost because of physical failures due to follies in education, or to impairments growing out of preventable maladies.

I have a fixed belief that a population below the normal level of health is sure to be also below the norm of goodness: I am as firm a disbeliever in the utility of long-disordered health to make men better. You remember what Becky Sharpe said of goodness: "I should have been a good woman had I had £5000 a year." Trust me, a large income of health means for the many, capacity to live at their moral best for themselves and for their fellows. Poverty of blood, like poverty of pocket, has its temptations.

Others to-day will tell you how the ill-health which comes to masses of men in epidemics affects the economic prosperity of a community—how vast is its influence, how untraceably far-reaching. I have chosen rather to hint at the ill results as to morals which may arise from lowered health, owing to the poverty it entails, the direct and indirect temptations it creates, the self-indulgence it fosters in a variety of forms. It were easy to point this moral with many a sad tale. The

story of every great epidemic—the plague, the cholera, yellow fever—is dark with histories of human baseness. But there are, in our vast cities, influences more or less capable of remedy, which cause no death and put none at once to bed, and which, nevertheless, entail on communities lowered conditions of health, affect the enterprise and spirits of men, and morally and mentally depress so as in subtle ways to cause degradation, desire for alcohol, and degenerative changes.

In a few pregnant sentences I have tried to set before you this novel question of the influence of health on morals.[1] I dare not linger on a tempting theme; I started with a text, and find that I have given you but a string of texts—may I not trust the sermon to your own intelligence?

To teach the individual the preservative laws of life; to teach the city, the commonwealth, the country how to avoid and subdue epidemics; how to provide that every water-course be kept sweet and pure; the air of cities uncontaminate; manufactories innocent to health—these are the large lessons which our school-house of health is to teach.

Thinking of our new enterprise, and, too, of the individual failures which may come out of an insufficient capital of bodily health, I am suddenly reminded of the holiday which the nation is now keeping. No thoughtful American can face an audience to-day, whatever may be the more remote purpose of his speech, and fail to think of one great historic figure. Let me bring him into relation with our own business of the hour. He represents for me that admirable form of hygienic preparation for a time of strain and trial, which came out of a vigorous, manly, out-of-door struggle with the exigencies and risks of the life of an engineer and frontiersman. Sound alike in mind and body, of clean descent, his

[1] At the time this address was delivered I had not read a very admirable article by Dr. Frances Emily White, Professor of Physiology in the Woman's Medical College, on "Hygiene as a Basis of Morals." I recommend it to all who are further interested in the subject.

consummate physical health must have had much to do with the clearness of head, the constancy of energy, and the perfect courage which carried him through the worries, the doubts, and the darkness of disastrous days. It would be easy to make for this picture of successful health a sad, contrasted background of historic failures, of national defeats, of perverted genius due to the want of this one thing—health.

A hundred illustrations crowd upon my memory, but without apology I turn from the great presence I summoned for a moment to point the moral of the hour, and leave with you the thought of the value to greatness, aye, to all goodness, of sturdy health.

And now, a brief summary of the history of the birth of this Laboratory and School of Health.

A few years ago, a grave loss of one very dear to my friend, Henry Charles Lea, turned his ever-active attention to the progress of science in its later revelations of the cause of consumption. The vast discoveries of Pasteur led up to Koch's convincing proof of the rôle played by minute organisms in the causation of tubercle. A multitude of like researches followed with confusing swiftness. One disease after another has been traced to its parent cause in some tiny agent of mischief. A row of culture-tubes in a laboratory, with their bright-colored organisms, represents a Pandora's box of pathological disaster. But a little while ago the strong advance of medicine seemed to be stopped as by a wall. Then, of a sudden, wide gateways opened, and behold this magnificent outlook—this broad road with its numberless byways—and so, again, we go forward with intellectually invigorated hope.

Apprehending the value of the many ways thus open to beneficent knowledge, Mr. Lea proposed to us to create a School of Hygiene, in which not only should we teach the art to live, but where also the new and effective helpmate of hygiene—bacteriology—should be provided with means of

developmental research. It became clear, somewhat later, that we could hope before long to place in directive charge of the whole work the one man best fitted for it in America—Surgeon John S. Billings, of the Army. The well-known modesty of my friend forbids me to say too much of him. The varied tasks he has accomplished serve well to show that a man may be master of many arts, if only he be so constructed hygienically as to be permanently endowed with that unending energy which this man has brought to the administration and construction of museums, libraries, hospitals, to the creation of unsurpassed catalogue and dictionary, to the medicine of war, and to the study of hygiene. This half-dozen men in one is the Director of our new enterprise. The fact that he was to be at its head induced Mr. Lea to increase his gift for a building to $50,000. On hearing of this, the late Henry C. Gibson at once offered $25,000 as means for equipment.

I pause to render my tribute of thankful praise to the memory of this kindly, gentle, and most generous man. He had the art of giving with such courteous simplicity as made those who sought his bounty feel that he was the one obliged. He had, too, at need, the art of saying "No" in such a fashion that you felt sorry for his manifest disappointment. To no other man was this great school so deeply in debt for repetitions of large gifts.

Mr. Lea has declined to be himself the immediate agent in transferring to the Trustees the admirable building, which is now fully fitted up and ready for active work. Standing here in his place, I am unwilling to annoy my friend of many years by too vividly saying what I think of his thoughtful and splendid gifts to the Philadelphia Library and to this University. But I find it impossible to do as he would wish, and to pass by without comment the man who has given us a new means of usefulness. I prefer to hurt his sense of reserve, rather than to sacrifice my own selfish sense of justice.

As the head of the oldest medical publishing firm in the world, Mr. Lea was so fortunate, or rather so able, as to win for himself the leisure out of which has grown a series of historical works without rival in their special line.

Most of you better know how often this quiet and retiring scholar has come out of his mediæval studies to make a sturdy fight in the cause of political reform, and to wage fierce war against municipal misrule. My words would disturb him, were he here to-day, but, surely, we are not too prone to praise. There is a time for all things, even for honest recognition of a pure, a true, an honorable life, and of the good and manly work of a model American, a gifted scholar, a generous man. And now he turns to give to this city the only Institute of Hygiene in America, and, with far-seeing thoughtfulness, asks that the engineer, the architect, and the physician we train shall be obliged to profit by its lessons as part of their education. I have asked that he would at least say by proxy a few words, and here is the brief message he has authorized me to deliver:

"My Dear Dr. Mitchell: It gives me pleasure to respond to your request for a few words on the objects and motives which led to the founding of the new Laboratory of Hygiene.

"Of all the claims of your noble profession on the gratitude of mankind, perhaps the chiefest is due to the zeal of its members in laboring as earnestly for the prevention as for the cure of disease, Scientific hygiene is essentially the creation of physicians who have ever been foremost in discovering and promulgating the facts and principles on which improvement of public health must be based. Great as have been the strides of this science during the last generation, even more is reasonably to be expected of it in the future. It is not visionary to say that we are on the threshold of discoveries which promise, if rightly used, to relieve humanity from some of the distressing evils which have weighed it down in the past. To this most desirable consummation the University of Pennsylvania makes a notable contribution in rendering the study of hygiene compulsory on all who seek its degrees in Medicine, Architecture, and Civil Engineering, and in organizing a Department of Hygiene, where scientific investigations and instruction can be considered under the most favorable conditions.

"Important as will be the functions of this department in stimulating original research, perhaps even more immediately important to the community will be its educational activity in annually sending forth numbers of thoroughly trained and well-equipped hygienists. Through their agency we may expect that popular errors will be largely dispelled and popular indifference to the laws of health will be removed. The mass of human misery directly traceable to these errors and this indifference can scarce be over-estimated. Of this our own city offers a pregnant example. No great centre of population is anywhere more happily situated than Philadelphia with respect to hygienic advantages. It has every requisite for healthful and prolonged life in its soil, climate, facilities for drainage, abundance of pure water within reach, ample space over which to spread without overcrowding. If proper respect were paid to hygienic rules, preventable disease would be virtually unknown among us, and our annual death-rate would not exceed fifteen to the thousand. Yet during the past year the interments amounted to 22,649, which, in a population of eleven hundred thousand souls, is over 20½ per thousand. Now, this difference of 5½ per thousand means about 6000 deaths per annum from purely preventable causes—6000 human beings snatched away before their time, and other thousands reduced to want by the loss of those on whom they were dependent. Yet, ghastly as is this aggregate, it is in reality the smallest portion of the evil. Experience shows that every death represents about twenty cases of sickness not immediately fatal, so that 6000 preventable deaths per annum infer 120,000 cases of preventable sickness. Each case of sickness will average from thirty-five to forty days, so that every year in Philadelphia there are 12,000 years of preventable sickness endured by its inhabitants.

"Think what an aggregate of suffering this represents—think of the thousands of families who are annually exposed to privation through the disability incurred by the bread-winner or by the mother—think how many of those who are hovering on the border between comfort and poverty are permanently plunged into pauperism through temporary sickness—and you will agree with me that the Department of Hygiene, if rightly administered and efficiently supported by the public, will be not merely a valuable scientific adjunct to the University, but will be the most practical and the most useful institution of public beneficence that the community can have, for it will deal in the largest way with the causes of these vast evils. If it is blessed to relieve human miseries, it is still more blessed to prevent them.

"Faithfully yours,

"HENRY CHARLES LEA."

What more can I add to this clear and touching appeal? Ah! but there must be some among you who will read between its lines their own memories of glad young lives sacrificed to diseases which should hardly exist, or of the days of doubt and heartfelt anguish, which ended more happily, but can never, never be forgotten. There can be few of us in this typhoid-smitten city who have not walked of late in the shadows of this needless calamity. Try to believe with me that, in a rightly organized municipal life, these evils may be greatly lessened. They are not necessities of God's making. Try, ah! try with us to think that much of pain and disease is but the stern consequence of some sin of omission or commission, or of the indifference and unintelligence of an inert community.

Mr. Lea's gift was conditioned on the raising of $200,000 as an endowment. The Trustees were themselves so assured of the need for this department, that they gave in individual gifts not less than $35,000. The Professors contributed $12,000, and the Provost was enabled to secure for it the endowment of the Pepper Professorship of Hygiene, amounting to $57,000. Altogether the endowment reaches $213,000, inclusive of Mr. Gibson's gift.

If, now, you will in turn permit me to read between the lines of Mr. Lea's letter, and be eloquent where he is mute, this would be his brief addition:

The city and the community owe to my belief in their needs this school of health. A generous hand equipped it. To make it thoroughly all it should be—to buy for its use those precious instruments, competent chemists and bacteriologists—it lacks at least $75,000 of further endowment. Such words as these the giver of this Laboratory might have used to the many in this city who, doubtless, are ready to match his generosity.

When we have trained within these walls our missionaries of health, we shall send them forth in our University Extension work to tell the people that sweet air and pure water

should have a say in the ballot-box, and that whether Democrat or Republican divide the spoils of petty city office is a matter contemptibly indifferent as compared to insuring for masses of men immunity from disease, pure air, space, playgrounds for man and boy, books, baths, music. For honest health, men, aye, and their offspring, need more than security of steady employment. Work without chance of play of brain or limb makes Jack a dull boy, and a dull boy is nearer to possibilities of disease than a happy boy. Believe me, this large-minded view of the hygienic needs of a people is essential to the fostering of the best physical, mental, and moral qualities of a great nation.

I beg leave, Mr. Provost and Trustees, in the name of Henry Charles Lea, to transfer to your keeping the admirable building he has erected.

And you, sir, Director of the activities of our new Laboratory, to you we confide with trustful hope the broadly human interests of this enterprise. We believe that, in its practical aspects, the more remotely valuable results of pure science will not be neglected, and that the work of this Laboratory will represent that hygienic perfection of science in which constant energy, incessant experiment and observation, and a wise scepticism shall devotedly combine to evolve out of discovery knowledge applicative at last to the nobler uses of mankind.

It is my ardent wish, Mr. Provost, that, through the long years to come, when you and I and all here are gone, the quality of the work still done within those walls may continually justify the bounty of my friend—may help to make the city which is dear to him and to me more wholesome, and may improve and lengthen the lives of men.

ADDRESS OF WILLIAM PEPPER, M.D.,

PROVOST OF THE UNIVERSITY.

RIGHT gladly, Mr. Chairman, do I, on behalf of the University, accept from you as representing Mr. Henry Charles Lea and our dear friend, the late Henry C. Gibson, and their generous colleagues, this noble gift. Never has the circle of our University departments opened to receive a more welcome addition. To detect error, to discover and diffuse truth, has long been our labor here. Here first in the country was taught the august science of the law. Here, also, first was taught the healing art, and for well nigh one hundred and fifty years the history of medical science in America has been, in large part, that of our medical school, and now, in the fulness of time, which has brought the recognition of the larger truth that prevention, and not cure alone, must be our aim, is added the first Institute devoted to the study of the causes of disease and of the laws for maintaining health.

An observant and critical public will note the advantages which have resulted from the establishment of this Institute in connection with a great University.

While its individuality is perpetuated so far as desired by the founders, it is brought into organic relations with cognate departments to which it will contribute most valuable assistance, and from which, in turn, it will receive important cooperation. The vast services this Institute will render to science and society can be but feebly outlined at present. They will be gratefully recognized in the future.

My pleasant duty is to formally announce the acceptance of the building, its equipment, and its endowment, and to solemnly pledge the faith of the University to the strict observance of the conditions of the trust.

ADDRESS OF JOHN S. BILLINGS, M.D.

FROM those who have preceded me you have heard of the origin of this Laboratory, and something of the wishes, hopes, and expectations of the public with regard to it, as indicated by the donor, and by representatives of the University and the State.

You see clearly that this magnificent gift imposes a heavy responsibility upon those who are charged with the duty of managing it, and of seeing that it is so used as to meet the many and various demands which may rightfully be made upon it; and, in attempting to explain to you briefly what the Laboratory now is, and why it is as it is, I come before you oppressed with a keen sense of this responsibility, which is not lessened, but rather increased, by the fact that I feel that I am speaking to friendly critics.

For this new building, with its equipment and resources, is but an implement—a piece of mechanism—which may be used to shape products of vast importance, not only to the world as it is, but to generations not yet conceived; or which, on the other hand, may be so used as to be of little more importance to humanity than the toy tool-chest or the doll's-house of a child.

What this use shall be depends upon the force and skill applied to it; upon the materials submitted to it; upon the ability of those who guide it to foresee the direction in which at each moment of time it is best to move it; upon the knowledge and patience of those who are working in it; and, when all these are at their best, the results must still depend upon the decrees of Divine Providence, upon circumstances which no man can fully foresee, and which, therefore, no man can, with certainty, control to the end desired.

The position of laboratories in their relations to education,

to science, to technology, and to the executive departments of governments and the welfare of the public, has become a very notable one within the last fifty years. A laboratory—or, as it was called in old times, an "elaboratory"—is, as its name indicates, a place for labor, for work—and especially for skilled labor, in the making of delicate and difficult observations and experiments; for analysis, to determine composition and causes; for synthesis, to determine the results of new combinations; for solving old problems, and for stating new ones. It is not a museum, or a store-room, or a show place; nor does this kind of a laboratory offer much for sale, except opportunity.

Only an opportunity—just a few possibilities, offered to the man who desires knowledge, who wants to see, and touch, and try for himself. Yet this offer of such an opportunity is what distinguishes it from those institutions established for the benefit of individuals.

The ideal laboratory of the alchemist or philosopher of bygone days was a mysterious, dusky place, the operations in which were kept a profound secret, and which thus gained in repute what they could not have obtained by publicity and free criticism.

Laboratories planned and fitted for public use, offering to anyone who is able and willing to pay a moderate fee and to submit to a few simple regulations, not only opportunities for learning the details of the processes carried on therein, but also facilities and means for making special research that he could only obtain otherwise at great expense and loss of time; such laboratories, I say, are all of comparatively recent date.

It is not yet twenty years since the first separate institution of this kind was established for hygiene—and even now there are not more than a dozen such laboratories, specially built and fitted for their purpose, in existence throughout the world. Of these, the best known is probably that of the University of Munich, under the direction of Professor Pettenkofer, while the largest is that of Berlin.

This Laboratory is the first structure of its kind erected in the United States, and it therefore opens a comparatively new field of work in this country. What is the nature of this field, and what are its boundaries?

The object of hygiene is to preserve and to improve health, and there are few matters affecting the physical, intellectual, emotional, and moral condition of man as an individual, or of men in communities that may not come within the scope of its investigations. The destruction or avoidance of causes of disease is but a part of its objects—it is at least equally concerned with the means of making a man better fitted to resist these causes. "That kind of health," says Montesquieu, "which can be preserved only by a careful and constant regulation of diet is but a tedious disease." Disease, like health, is a vague term, including widely different and often very complex conditions, processes, and results, which must be observed, classified, and described in such a way that different men, widely separated in space and time, may know that they are seeing the same things, and thus may have the benefit of each other's experience.

In its scientific aspects, then—those which relate to definite and precise knowledge—hygiene rests largely on physiology and pathology, the third leg of the tripod being formed by vital statistics; while, in its practical aspects, it must rest on chemistry, physics, and the data of sociology and politics.

At any given time, therefore, its scope and practical value must depend largely upon the breadth and solidity of the foundations which these various branches of science can provide for it. The opinions of the medical faculty of Paris as to the causes of the "black death," and the advice which they gave as to the means for lessening the "great mortality," absurd and preposterous as they now appear to us, were yet fully in accord with the knowledge and opinions of the time.

At the beginning of this century physicians did not distinguish with any certainty between typhoid, typhus, and malarial fevers; or between consumption and various other

chronic diseases of the lungs, and, until this was done, investigations into the causes of these affections were necessarily almost fruitless.

When, however, a clue is once given to the student of causes, he may be able, by detecting differences in these causes, to call the attention of the pathologist to differences in the results, and thus the bacteriologist, by proving specific differences in microörganisms, all of which produce fever, suppuration, etc., induces closer study of details of cases by physicians, and the recognition of new and more clearly defined groups of symptoms and results, or, in other words, of new diseases.

We live in an age of specialization. Progress in science as a whole depends upon special progress in each of its branches. Our present knowledge of physiology depends largely upon the perfection of electric methods. Pathology and pathologic bacteriology are now waiting for increase of knowledge in organic chemistry. The law of evolution applies to this as it does to modern industrial progress.

The physician deals with sick men, and his first question is, What is the matter with this person? That is, What group of symptoms does he present, and to what derangement of his mechanism are these due? The hygienist deals with two sets of problems—the first relating to men who are not sick, and how their health and vital resistance-power are to be not only preserved but improved and strengthened; the second relating to sick houses, feverish blocks or wards, infected localities—where the first questions to be solved are, What are the causes of this condition of things? how have they found entrance? are they still acting?

In the investigation of causes he must consider not only the immediate or exciting, but also the remote or predisposing; not only those which are preventable, but those which, with our present knowledge, are unpreventable; and thus it is that heredity, race, local meteorology, occupation, and many other circumstances must be studied by him, as well as the effects of food, clothing, habitation, poisons, and viruses.

Much of all this was known to a few wise men long ago, as is shown by the scheme of inquiry stated by Lord Bacon in his *Articles of Inquisition touching Life and Death:*

"3. Inquire touching the length and shortness of life in living creatures, with the due circumstances which make most for their long or short lives.

"4. But because the duration of bodies is two-fold; one, in identity, or the self-same substance; the other, by a renovation or reparation; whereof the former hath place only in bodies inanimate: the latter, in vegetables and living creatures; and is perfected by alimentation or nourishment; therefore, it will be fit to inquire of alimentation, and of the ways and progresses thereof; yet this, not exactly because it pertains properly to the titles of assimilation and alimentation, but, as the rest, in progress only.

"Inquire touching the length and shortness of life in men, according to the ages of the world, the several regions, climates, and places of their nativity and habitation; . . . according to their races and families, as if it were a thing hereditary; also, according to their complexions, constitutions, and habits of body; their statures; the manner and time of their growth; . . . according to their fare, diet, government of their life, exercises, and the like. . . . But because it will be hard to know the ways of death, unless you search out and discover the seat, or house, or rather den of death, it will be convenient to make inquisition of this thing; yet not of every kind of death, but of those deaths which are caused by want and indigence of nourishment, not by violence; for they are those deaths only which pertain to a decay of nature, and mere old age. . . . Inquire touching the point of death, and the porches of death leading thereunto from all parts; so as that death be caused by a decay of nature, and not by violence."

Most of this is wise and far-seeing, yet little came of it for two hundred years. By way of contrast, let us take a few of the rules which Lord Bacon fixed for his own use, in order to prolong life:

"1. Once in the week to take the water of Mithridate distilled, and some grains of nitre and saffron, in the morning between sleeps.

"6. To take every morning the fume of lign-aloes, rosemary, and bays dried, which I use; but once in a week to add a little tobacco, without otherwise taking it in a pipe.

"10. In the third hour after the sun is risen, to take in air from some high and open place, with a ventilation of musk roses and fresh violets; and to stir the earth, with infusion of wine and mint.

"17. To use once during supper-time wine in which gold is quenched.

"28. To provide always an apt breakfast."

A curious mixture of good-sense and rubbish, these rules, which are well worth reading.

The scheme of inquiry as to causes of disease and preservation of health to-day includes most of Bacon's questions, and also many others of which he did not dream. Let us consider, briefly, some of those which belong to our laboratory work.

The recent advances in our knowledge as to the action of certain microörganisms in the production of disease in animals and man have been largely made by laboratory methods, and indicate clearly that the study of bacteria and microzoa, and of their development, products, and effects, must be an essential part of the work of a hygienic laboratory, which should provide the peculiar arrangements and apparatus which are required for this sort of work. In fact, several so-called hygienic laboratories are simply bacteriological laboratories, the interest in this particular branch of investigation having, for the time being, overshadowed all others.

Our laboratory, however, must provide also the means for chemical investigations of air, water, food, sewage, secretions and excretions, and the products of bacterial growth; for testing the effects of gases, alkaloids, and albumoses of various kinds upon the animal organism; for investigations in the

domain of physics, pertaining to heating, ventilation, house-drainage, clothing, soils, drainage, etc.

Perhaps a summary of what the German hygienic laboratories have been occupied with for the last five or six years, as indicated by the published reports and papers of those who have been working in them, will afford some indications as to the field which they have occupied.

First in number and extent, as just stated, come the bacteriological investigations relating to anthrax, tubercle, typhoid fever, erysipelas, suppuration, diphtheria, pneumonia, cholera, and other diseases of men and animals.

Closely connected with these are the experiments on disinfection, and the testing of various forms of apparatus for disinfecting by steam or by dry heat.

Next come examinations of drinking-waters, of the effects of various impurities in waters, effects of lead pipe on waters, self-purification of running waters, changes in stored waters, etc. The effects of working in compressed air; the air of school-rooms, of assembly halls, of hospitals; the dusts and germs of the air, its changes by respiration and by ventilation, form another group of subjects.

Foods and drinks have occupied much attention—the quantity and quality of different articles that are most desirable—their adulterations, preparation, and preservation, including studies of meats, bread, milk, beer, wines, meat-extracts, etc.

Soils of streets, gardens, cemeteries, etc., with reference to their moisture, gases, and bacteria, seem to have received much investigation.

Clothing, various kinds of lighting, of heating, of plastering, and of floors and floor fillings, have kept some of the students busy. "Poisonous colors in clothing," "Bacteria in rags, canned foods, damp walls, shoes, ice," "Modes of disinfecting walls and floors," "How can a polluted well be purified?" are titles taken at random.

Just at present, research is being specially directed to certain minute animal organisms—the microzoa—such as are

found in the blood in malaria and in the skin in certain diseases, and to immunity, especially to that immunity which may be artificially produced.

Experimental investigation is a slow process, and very uncertain in its results.

An experiment may be conceived which seems as if it would give important results. The experiment itself would require only a few moments or a few hours if all the apparatus were ready to produce the required conditions, and to record in terms of weight and measure the results obtained. But to make this apparatus in the best form, and to provide the means of recording, may take a year or more, and in making this preparation a dozen problems will come up to be solved by other experiments. You are pretty sure to discover something new, but by no means sure that it will be what you began to seek. Every discovery opens new questions and indicates new experiments, and the precise shape in which the work presents itself varies with place and season.

We cannot foresee precisely the demands which will be made upon us, or which we shall make upon ourselves, but we do know that we shall want some large rooms in which a dozen or twenty men can be at one time taught how to investigate, working under the eye of an instructor; and also a number of small rooms, each fitted for the work of one or two men who have attained a certain degree of skill, and are engaged in original research. In all of these rooms we shall at times need to use microscopes, gas-heating, and steam; there will be vapors and fumes produced; there will be delicate instruments scattered about, and the rooms must, therefore, be light, have abundance of gas, steam, and water, hoods and flues for conveying away fumes, and they must have plenty of fresh air without dust.

Many of the things that will be seen through the microscopes will be rapidly changing form, and we shall need pictures as well as descriptions of their different shapes.

The most useful drawings for our purposes are those made

by sunlight, and, therefore, we want photo-micrographic rooms.

We shall wish to test the merits of various articles of house-equipment, such as different patterns of steam radiators, of traps, of sinks and closets, etc., and for this purpose we must have places where they can be fitted and put into use.

We must know what other investigators in other laboratories, and many places besides laboratories, have done and discovered, that time and effort may not be wasted. We must, therefore, have the books and journals in which these are recorded, which are already many, and coming rapidly. A small library and reading-room is therefore essential.

Much of the apparatus to be used must be either made or specially fitted and adjusted on the spot to meet special indications which it is impossible to foresee, and, therefore, we need a large workshop, with tools and appliances for working in wood, glass, and metal, and with power.

Let us now look for a moment at the plan of the building, and see how all these things, and some other needs, have been provided for. Entering the building from Thirty-fourth Street, on the west front, we find, on the main floor on our right, that part of the building which is more especially intended for the use of those not working in the research-rooms, but coming in from the Arts or Engineering and Architectural Departments of the University for special lectures and demonstrations. This contains a lecture-room and class-room, a room for preparing apparatus, etc., for demonstrations, a small museum-room, and the janitor's office. The lecture-room is fitted with various devices for experiments and demonstrations upon different methods of heating and ventilating assembly halls, such as school-rooms, churches, theatres, including means for propulsion or aspiration of air, for introducing and removing it at various levels, etc.

On the left of the vestibule are doors which separate the laboratory and research part of the building from the semi-public portion just described.

First Floor Plan

Laboratory of Hygiene,
University of Pa., Phila.

Collins & Autenrieth.
Architects.
410 Walnut St. Phila

Second Floor Plan

Laboratory of Hygiene,
University of Pa., Phila.

Collins & Autenrieth,
Architects,
410 Walnut St., Phila.

Passing through these, we have in front of us the large chemical laboratory in which the students are to be made practically familiar with methods of examining air, water, foods, soils, etc. Next to it is the balance-room. Then come, on the north front, four special research-rooms, and on the south one research-room and a large drafting-room for the preparation of drawings and plans relating to heating and ventilation, house-drainage, sewerage, and water-supplies.

The radiators in the large chemical laboratory on the north front are each of a different pattern, and so arranged as to permit of the testing of the relative efficiency of each, or to permit of the substitution of other forms for such testing.

Ascending to the second floor, the outlines of which are the same as those of the first, we find, over the chemical laboratory, a large bacteriologic laboratory well lighted from the north, with working places for twenty students.

On this floor are five research-rooms, the photograph and photo-micrographic rooms with dark-rooms, the director's room and private laboratory, a library and a supplies-room.

The basement contains a large, well-lighted workshop, a combustion-room, a cremating furnace, a boiler-room, and an engine-room, and rooms for the janitor.

I will not go into details as to the purposes and uses of the various flues, hoods, pipes, and valves which you will see in every room. It is sufficient to say that they are designed not only for the convenience and use of the workers, but for experiments and demonstrations of many kinds.

The drainage of the building is on a double system, and is so arranged as to permit of the trial of new forms of traps, sinks, closets, etc. All pipes are freely exposed to view, and the different systems for cold water, steam, drainage, etc., are each painted a different color.

When you visit the Laboratory—as I hope you will do not only immediately after these exercises, but many times in the near future—you will see more clearly its arrangement than you can from a mere inspection of the plans.

As regards the external appearance of the building, opinions will, of course, differ. I will only say that it has been planned from within outward, which is the reason why it looks like a laboratory and not like a castle or a cathedral; and there is very little useless exterior decoration. Sky-lines and projections or recesses to obtain shadows have not received much consideration; space, light, and adaptation to the work to be done have been the points insisted on.

In many respects it affords a striking contrast to the library building in which we are assembled, and it is fit and proper that it should do so. The library represents the garnered experience and wisdom of the past; the laboratory is the workshop of the future. One is fruit, the other is seed.

In this connection I wish to express my high appreciation of the important work of the architects, Messrs. Collins & Autenrieth, of this city, in preparing the plans and specifications for this building and in supervising its construction, and especially to thank Mr. Collins for the many valuable, practical suggestions which he has made as the result of his careful study of our purposes and needs.

So much for the building and its contents as it is, and why it is as it is. The chief object of its existence is to fit a certain number of men from all parts of the country to investigate and solve the problems connected with the securing of the best health and vigor among our people.

We hope, also, that some increase of knowledge will be made here by the workers in the Laboratory itself; but the main point to be kept in view is to provide well-trained, scientific, and practical men for other fields of labor. Dr. Mitchell has said that the true rate of advance in medicine is not to be tested by the work of single men, but by what the country doctor is. So, also—and even more so—advance in practical sanitation is not to be measured by laboratory records, but by what health officers and sanitary engineers are able to accomplish.

Even now we *know* much more than we *do*, and the skilled

sanitarian too often finds himself in the position of the unhappy daughter of Priam and Hecuba, who could foretell, but to no purpose.

This Laboratory is fortunate in being closely connected with, and in the immediate vicinity of, a great medical school, and of great hospitals. As was said before, one of the essential foundations of scientific knowledge of the causes of disease is minute and accurate diagnosis and pathology, and we are, therefore, in constant need of the best knowledge of leaders in these branches of medical science. The hospital is filled with specimens of the results of such causes, acting on the human body—from one point of view, Nature's experiments with poisons cunningly elaborated in the tissues of the body, or with viruses coming from without, upon blood and bone, muscle and brain. Much of the work of this new department will be connected with the results of these experiments.

The Laboratory is also fortunate in being located in a great manufacturing city, where the effects of different occupations, of trades dangerous or offensive by reason of dusts, or of vapors, or of waste-products, can be readily observed and the materials for study obtained. There is an immense field for a sanitary clinic here, and in the habitations, the streets, the water-supply, and the sewers of Philadelphia.

These clinics, however, cannot, as a rule, be reported for the press, either lay or medical, since to do so would, to a great extent, defeat their object; the great majority of sick houses and manufactories must be considered as strictly private patients, and their affairs held as confidential. In the case of public institutions, or of public nuisances, a somewhat different rule may apply.

Practical hygiene is to play an important part in municipal government, to secure the best form of which is now one of the most urgent questions of the day. Many of the questions to be decided by city officials as to water-supplies, sewage-disposal, etc., require expert knowledge to answer.

Of course, the subject of hygiene and the work of a Uni-

versity department devoted to the increase and diffusion of knowledge in sanitary science extend far beyond the experiments and demonstrations for which this Laboratory is specifically fitted.

Bacteriology, chemistry, pathology, physics, and medical and vital statistics give us the foundations, but sociology and jurisprudence must also be studied in their relations to sanitation to obtain the best results.

It is in and to the home and the workshop that these results are to be applied, and he who aspires to be his brother's keeper must know how his brother lives.

Labor questions, education questions, maritime and inter-State commerce questions, and methods of municipal finance and government are all intimately connected with matters of personal and public hygiene; and economic consequences, as well as health, must be considered in the advice and regulations of the sanitarian.

I count it as fortunate, therefore, that there is a law school and a school of finance and political economy in this University to which the Department of Hygiene can look for advice and friendly criticism when these are needed, as they surely will be.

And now a very few words as to the needs of the Laboratory. First of all it needs men—men thirsting for knowledge, and fitted by previous training and education to come here and acquire that knowledge, not merely the knowledge that exists in books or that the teachers in this Laboratory may possess, but that which is yet unknown, the weight of that which no one has yet put in the balance—the shape, and size, and powers for good or evil of things the existence of which has not yet been demonstrated—men who will patiently and earnestly seek the answers to the questions, "what?" "when?" and "how?" in the hope that thus they may by-and-by obtain some light upon the more difficult problems of "whence?" and "whither?" even if they may never be able to answer "why?"

There are not many such young men whose tastes will be in the direction of these lines of research, and of these there will be very few who will have the means to support themselves while engaged in the work. We need, therefore, the means to help them in the shape of half a dozen fellowships, paying about five hundred dollars a year each, and granted only to those who give satisfactory evidence of capacity and zeal.

The second thing we want is a demand on the part of the public for really skilled, well-trained sanitary investigators and officials, such as we hope to send out from here; we want a market for our product; we want the legislators of this and other States, and of our rapidly growing municipalities, to be educated to appreciate the importance and practical value of such health officials, and to give the best of them employment.

Thirdly, the Laboratory wants the coöperation and assistance of sanitary authorities and inspectors, and especially of those of this city and State.

It needs to know from time to time what they are interested in and are working at, to have the opportunity of showing to its students cases of special interest—sick houses, localized epidemics, special forms of nuisance.

And, on the same principle and for the same reasons, it desires to have its attention called to special methods of heating, ventilating, and draining buildings, and especially public buildings, such as schools, hospitals, prisons, churches, and theatres, and to matters connected with the hygiene of manufacturing establishments and special occupations, methods of disposal of offensive or dangerous waste-products, of protecting workmen against dusts, gases, etc.

In short, we want to know how these things are managed by the men who have a practical interest in them; and if, in our turn, we can suggest improvements, we shall be glad to do so.

Fourth, the Laboratory wants a reference library as com-

plete as it can be made, and always up to date. Many of the books and journals required must be purchased, and for this purpose a special fund is needed; but many of the works required can only be obtained by gift.

Thus, we want all the reports of boards of health—State and municipal—of municipal engineers, water-works and water commissioners, park commissioners, etc.

We want the catalogues and circulars of all manufacturers of heating and ventilating apparatus, of plumbers' supplies and house fixtures, of electric and gas fixtures, of machinery and apparatus connected with water-supply and sewage-disposal.

We want copies of plans and specifications of large buildings of all kinds.

And these things can only be obtained through the aid and good-will of manufacturers, engineers, architects, and sanitarians all over the country; and this aid I venture to ask, feeling sure it will be granted by those who know what is wanted.

I will mention but one more special want to-day, and that is of means for the proper publication of illustrated reports and accounts of the work done in the Laboratory.

In the meantime we must be patient and not too eager to touch the fruit of the blossom that is not yet blown.

In the chambers of this Laboratory are to be explored and tested some of the strangest and subtlest of the manifestations of force which surround and are within us.

Here we are to deal with problems of life and death; to seek to unravel some of the webs which bind and choke our children, and which make our strong men helpless, that we may for a time, at least, put these trammels aside, or sever them.

I dare not attempt to promise or to prophesy as to the work which will be done here, or as to the future of this new department of the University.

Those who are to be connected with it may not do the best that can be done, but at least they must do the best they can, and, if needful, give place to others who can do better.

Those to whom we owe this Laboratory and its equipment and endowment, have been generous and wise in their generosity, which has been in accord with the teaching of the son of Sirach, "Having grace in the sight of every man living, and detained not for the dead."

Death comes by many paths to one or other of the three porches of the microcosm through which he enters, and brings his poppy flowers to all doors soon or late; but if we knew that which we might know, and did that which we might do, he would be preceded by fewer heralds of suffering, and would arrive only when we were ready to be "hushed in the infinite dusk."

If "ye shall know the truth, the truth shall set you free" —not free from change, or from grief, or from the final passage beyond the veil, but free from causeless fears, from unnecessary pain, from useless labor; and this is a part of that wisdom "which passeth and goeth through all things," and is "the brightness of the everlasting light, the unspotted mirror of the power of God."

ADDRESS OF BENJAMIN LEE, M.D.

Mr. Provost, Ladies, and Gentlemen: I trust there is no one present on this memorial day and this auspicious occasion whose bosom does not swell with patriotic pride at the thought that he is an American citizen.

Recalling, as we are wont, the virtues of him whom, above all others, we are accustomed to regard as the founder of our liberties, let it be a part of our grateful observance to sum up the blessings which flow from them. And that we may the better appreciate them, let us compare the wretched lot of the denizens of cities of the Old World, groaning under the iron heel of despotism, with our own more highly favored circumstances. The tyrannical rulers of those down-trodden peoples actually presume to interfere with their meats and drinks —forbidding them to quench their thirst with water enriched by the sewage of cities, hallowed by the infusion of the remains of their dead ancestors, or delicately tinted with the drainage of coal mines; or to refresh themselves with beer rendered aromatic and enlivening by cocculus Indicus and strychnine, or wine manufactured from the juicy apple and the generous turnip, or tea composed of rotten leaves and catechu and colored with verdigris, or coffee innocent of Java and Mocha, or chocolate in which the offensive cocoa butter has been entirely replaced with tallow. They are not permitted to eat the flesh of tuberculous cattle and trichinous swine, while we are freely allowed to feast on those which have been condemned for their markets. Even the little children are forbidden the delights of sucking candy brilliant with arsenic or munching buns beautified with chrome yellow.

The very air which they breathe is deprived of the fragrant and nutricious elements which we enjoy in ours, by the removal of manure and other putrefactive substances from the streets before they have had time to pulverize or decompose.

Thus, these unfortunates are hedged in on every side by onerous ordinances and petty infringements of their liberties, of which we know little or nothing.

But lest this hurried *résumé* of our causes for exultation should make us too vainglorious, I would ask your attention for a moment to a feature of our republican form of government which is perhaps less encouraging.

I refer to the acknowledged fact that legislation of what may be termed the higher order, which recognizes the arts and sciences, and aims to lift the people to a higher plane of culture and civilization, and which is founded on the most recent revelations of science, is not to be expected of our municipal and State legislators. And, indeed, so true is this of our own State, that a clause actually exists in the Constitution forbidding the outlay of the public funds for any such purposes. Hence, if institutions of learning of a high grade, or devoted to specific objects, are to exist among us, they must owe their origin, and to a great extent their support, to the public spirit and generosity of private citizens. Perhaps this is not an unmixed evil. Perhaps it is well that in the mad haste to get rich quickly which characterizes our people, there should be a constantly present condition which evokes brilliant examples of public giving as contrasted with individual grasping. Certainly, magnificent instances of such liberality exist all over our broad land, and perhaps nowhere have more frequent benefactions of this kind increased the opportunities of a great institution of learning, than have of late years been poured into the lap of the venerable University who has called us together to-day to rejoice with her over the reception of her latest gift, and the opening of the newest and loveliest flower in her coronal.

The announcement that this Laboratory was about to be opened was received by the State Board of Health with the liveliest satisfaction, as marking an era in the progress, not of science simply, but of civilization in this State, and a conference with its officers was requested in order to formulate a plan by which the Board might avail itself practically of the facilities which it would afford.

Such a conference has been held, and to me has been assigned the duty of briefly stating the conclusions which were reached.

The necessity of a Laboratory of Hygiene to the State Board of Health has been urgently felt from the first moment of its establishment, and arises out of the duties imposed upon the latter by Act of Assembly.

To carry out in any adequate degree the purposes of the law with regard to investigating the causes of disease, and the effects of foods, beverages, and medicines on the health of the people, two things, among others, are absolutely essential: first, that the Board should have means and opportunities for making or procuring *chemical analyses;* and, secondly, that it should have the means and opportunities for prosecuting what are now known as *bacteriological examinations*—the study of the germs of disease. And it goes without saying, that where the interests of the health and lives of five million people are concerned, these means and opportunities should be on a generous scale, and should conform to the most recent developments of scientific hygienic research, both in this country and in Europe. Nor is it fitting that this great Commonwealth, with its millions of revenue, should be depending, as it has done—I say it with burning cheeks—on the charity of private chemists, who have, in a spirit of generous patriotism, placed their services at the disposal of the Board in order to enable it, in some slight degree, to meet the claims that are constantly and properly made upon it for the analysis of suspected waters and foods. It is hoped, therefore, that the Trustees will see their way clear to allowing the Board to refer applications of this kind to the Laboratory for investi-

gation. The Board, for its part, will make every effort to obtain from the Legislature a reasonable appropriation for such purposes, distinct from its general appropriation, which will enable it to meet at least the cost of all work done for the State.

Further, the Act creating the Board instructs it, "from time to time, to engage suitable persons to render sanitary service, or to make or supervise practical and scientific investigations and examinations requiring expert skill, and to prepare plans and reports relative thereto."

Here, again, the Laboratory will prove the right hand of the Board, giving just that instruction which a sanitary inspector needs to make him an "expert," a "suitable person" for his special work. And, on its side, it will be the object of the Board to pursue more persistently even than it has in the past, its purpose of obtaining a thorough sanitary organization of the State under legislative sanction and compulsion, the result of which will be to create a constantly increasing demand for such trained practical sanitarians as this school will graduate. In this view of the case, it might be the part of wisdom for you, gentlemen, Trustees, to place a certain number of scholarships at the disposal of the Board.

Finally, it is desirable that publicity should be given to the important work which will be carried on in this Institute, which I risk nothing in saying, after a careful inspection, and after comparison with other similar laboratories, will be far in advance of any in this country, and the peer of any abroad. And I therefore suggest that its Director present a stated report quarterly, or at such other interval as may be deemed expedient, to the State Board of Health, of all investigations here prosecuted directly in the interest of the public health, which report shall form a portion of the Annual Report of the Board to be transmitted to the Governor, and of which a certain number of reprints shall be furnished to the Trustees for general distribution, as well as for preservation in the archives and various libraries of the University.

The edifice whose inauguration has drawn our willing feet hitherward, ladies and gentlemen, is a temple of Hygeia in a truer sense than were those fair structures whose marbles flashed back the morning light on the hills of Greece and Rome.

It is in honor of the "sweet smiling Goddess of Health" that we are met.

The fabled daughter of Æsculapius, her temple ever nestled under the shadow of his loftier fane, as does that which we dedicate to-day, and her lovely image was sometimes seen in the same shrine, even side by side, with his severer figure.

May I be pardoned for appropriating to her praise the beautiful sonnet of America's most American poet, addressed by him to a sister divinity, whom also we glorify on this national anniversary:

> "Who cometh over the hills,
>   Her garments with morning sweet,
> The dance of a thousand rills
>   Making music before her feet?
> Her presence freshens the air,
>   Sunshine steals light from her face,
> The leaden footsteps of care
>   Leap to the tune of her pace.
> Fairness of all that is fair,
>   Grace at the heart of all grace!
> Sweet'ner of hut and of hall,
>   Bringer of life out of naught—
> Hygeia, oh, fairest of all
>   The daughters of Time and Thought!"

ADDRESS OF H. P. WALCOTT, M.D.

My own slight claim to a place upon this platform, and the still greater privilege of addressing you to-day, rests, I presume, upon the fact that for a number of years my time has been largely devoted to the work of a State Board of Health that has had the responsibility of carrying on investigations which have been made possible only by the aid of competent observers and the resources of specially equipped laboratories. We did not, indeed, find a Laboratory of Hygiene ready to our hands, housed in a structure equal to the noble edifice prepared for you by a generous public still mindful of the words of that great American who, in his last will, remembered with equal generosity the cities of his birth and his adoption. He declared, as I need not remind you, in the preamble to the constitution of the academy he had founded, that it was begun for "teaching the Latin and Greek languages, with all useful branches of the arts and sciences suitable to the state of an infant country, and laying a foundation for posterity to erect a seminary of learning more extensive and suitable to their future circumstances." Wise and far-seeing beyond most men of his or any time, Franklin even had probably no conception of the splendid superstructure that would be raised here before the third half-century from the foundation of the academy had elapsed. But when I also read again the provisions of the codicil of his last will, where, after giving to his native town of Boston a certain sum of money, he bestows an equal amount upon the city of Philadelphia, and recommends that at the end of a hundred years, if not done before, a provision be made out

of this fund for bringing into the latter city a supply of water, it seems most appropriate that, among other things, something should be said about the investigations carried on by the Board of Health of Massachusetts into the purification of water and measures for preserving its purity.

Our various Commonwealths, however widely separated, have substantially the same interests in measures for preserving and increasing the general health. They will not much differ in the means adopted for procuring this protection and development. I shall, therefore, speak of the experience of my own State in these matters, not in any spirit of narrow provincialism, I hope, but simply because I feel a certain assurance in the value of our experience and a belief that the knowledge so gained may be of service here.

The sanitary laws of any community are almost invariably the most arbitrary with which public authorities are charged. Under the statutes of Massachusetts for the prevention of the adulteration of food and drugs, a person may be convicted for a violation of the laws who has, perhaps in good faith, sold an article of food or a drug which does not come up to a required standard of purity which his own unaided senses cannot determine, and for which he must seek the services of a trained analyst, and yet he may himself have purchased the article from a dealer in another State, and may have every reason apparently for his belief in its purity. So, too, a local board of health may pronounce a house to be unfit for human habitation, and may order it to be vacated forthwith; may declare a profitable place of business to be occupied by an offensive trade and dangerous to the public health, and, in consequence, order the manufacturer to cease and desist from an occupation which supports himself and many workmen and their families. Many more instances of the exercise of such extreme powers by legal authorities might be given. It is unnecessary, though, because you are all familiar with them. I will mention but one, however, because it is the most serious invasion of private rights known to me—and

that is compulsory vaccination. Why do the people submit to all these high-handed measures? In the first place, because they believe that human health is often needlessly put in jeopardy; and, second, because an effective remedy can in no other way be secured than by prompt and energetic action at the hands of a competent body of experts.

It is one of the strongest tributes to the conservative influences of scientific training and of the intelligent practice of medicine that we can truthfully claim that very few of our sanitary authorities have used these great powers harmfully. There has, therefore, been no serious attempt to deprive such authorities of their prerogatives. But as these functions are given to certain men because they are believed to be experts, they must at all times satisfy the people that they really do possess a better knowledge than other men have of the influences affecting the public health.

For many centuries the general practitioner of medicine, wrapped up in his all-engrossing mission of curing disease and the relief of pain, was the only man to whom the community would trust the task. He did the work as well as it could then be done, for he knew all that was known in his day upon the subject. This close limitation of sanitary work to the medical profession ceased to be complete with the introduction of public registration of vital statistics. A registrar of deaths then had a better knowledge of the dimensions of a fatal epidemic than a single physician could have, and in Massachusetts, at least, the introduction of a registration of vital statistics, in 1842, was followed by the formation of local health boards which in some instances did not contain a single physician. This state of things, in turn, prevailed until the real significance of our vital statistics was better understood, when the State Legislature that established district boards of health also directed that one of the three members should be a physician.

From the early days of the Massachusetts Colony there had been sanitary legislation; and remembering the oft-repeated

warning of our greatest authority in sanitary statistics—and there is no greater the world over than Dr. Billings, the honored Director of this Institute of Hygiene—that vital statistics are of necessity the basis of public medicine, it is with satisfaction that I recall the fact of a Colonial law, bearing date 1639, which provides "that there be records kept of the days of every marriage, birth, and death of every person within this jurisdiction."

Our first registration reports were, necessarily, imperfect; but the data to be derived from them were the foundation of all our permanent sanitary legislation. For by the facts here presented has it alone been possible to convince the public authorities of the need of sanitary legislation and to persuade them to make the appropriations of money required to make such legislation effective.

The first noteworthy contribution to our sanitary history was the report of a board of commissioners appointed by the Legislature to prepare a plan for a sanitary survey of the State. Accompanying the report, which was made in 1850, was a draft of a bill for the purpose of creating a State and local boards of health. No action was taken by the Legislature at that time; the seed, however, had not fallen upon a wholly barren soil, though it was eighteen years before our State Board of Health came into existence.

This earlier sanitary movement happened at a time when the scientific investigation of the communicable diseases had made but little progress, and the doctrines which then passed current upon the subject of the spread of epidemics have been long since displaced by the carefully conducted laboratory researches of recent years. The registration reports had, however, exhibited definite numerical standards which were quickly used by the medical profession in place of the uncertain measures of disease previously in vogue, and we have thus been able to obtain many valuable State and municipal sanitary reforms.

Among the results of the education in matters affecting the public health was the establishment of a State Board of Health in 1869. Some of the duties of the new organization are set forth in the following words: "The State Board of Health shall take cognizance of the interests of health and life among the citizens of the Commonwealth. It shall make sanitary investigations and inquiries in respect to the causes of disease, and especially of epidemics and the sources of mortality, and the effects of localities, employments, conditions, and circumstances on the public health; and shall gather such information in respect to those matters as it may deem proper for diffusion among the people." Subsequent legislation added to these general functions the immediate supervision of the inland waters of the State.

Some of the conditions affecting the public health in Massachusetts are peculiar in degree, if not in kind, and distinct from those that have as yet gained much importance in other States. The evil effects of overcrowding in the tenement-houses of her large cities are not different from those observed in other cities of the same class all over the Union. She has suffered at one time or another from the epidemic diseases which have afflicted her neighbors. But she, earlier than all the rest, with the exception, perhaps, of Rhode Island, has begun to find it difficult to procure for several of the large cities in the eastern part of the State a sufficient supply of pure water for domestic purposes. The two large rivers of the State are already polluted before they reach her borders, and some of her own streams are, in consequence of seemingly unavoidable pollution, not fit for domestic water-supply.

In this state of affairs the Legislature determined to do two things: in the first place to find out how seriously polluted the existing sources of water-supply were, and then to ascertain what remedy could be applied. These investigations were placed in the hands of the State Board of Health. This body was soon convinced that there existed no examinations of a chemical and biological or even physical kind sufficiently

extended over times or places to serve as standards representing the normal condition of even the most important water system. It was, therefore, determined to make such extended studies of these supplies as might be necessary to give a correct view of the whole life history of a water-supply.

If a single chemical analysis disclosed all that can be known about a water-supply, it would not have been necessary to make any very elaborate arrangements for carrying on the work of investigation. Unfortunately, the most complete analysis reveals nothing beyond the condition existing upon the day when the specimen of water was taken for examination. A single analysis may be taken from any long series of examinations of polluted water-supplies with which we have had to deal, and it may show a water of apparently good quality, yet the whole series, if carefully studied, would show the presence of products of decomposition of organic matter in large and probably dangerous amounts.

As there is no such thing as an absolutely pure and uncontaminated water in nature, it also became necessary to study with equal care the nature and behavior of those pollutions most likely to affect waters injuriously. First among these are the waste-products of human life, both in health and disease. It was apparent from the beginning, that work of this character could not be carried on to a satisfactory conclusion without a well-equipped laboratory. It was necessary, then, either to create such a laboratory—a task which it was not considered wise at that stage of the inquiry to undertake—or else to secure the assistance of trained investigators in existing institutions for chemical and biological research. The latter course was taken, and the special laboratories of the Massachusetts Institute of Technology were generously placed at the disposal of the State authorities. Prof. Brown, with whom has been associated from the beginning Mrs. R. H. Richards, had charge of the chemical work. Mr. George H. Parker, of Harvard College, and, later, Prof. W. T. Sedgwick, of the Institute of Technology, have conducted various branches of

the biological investigation, with the assistance of a number of well-instructed and interested observers in the various departments.

With no satisfactory knowledge of the life history of any single water-supply, either as to its varying chemical composition, or the numbers and kinds of the animal and vegetable forms of life found therein, it was determined that these investigations, which were not at all likely to be pursued on a sufficiently comprehensive plan by private individuals, should extend into fields which lay in no apparent or close connection with questions involving the public health. The Board distinctly understood that these examinations might not present for years results that could be made available in the routine work of a board of health; but it did firmly believe that in no way but by a rigidly scientific, even if slow, process of investigation could the varying characters of natural waters be ascertained, or the nature of the causes of these changes be understood, whether consisting in the presence of animal or vegetable life and death, or in the products of human waste. It did not seem presumptuous to anticipate that when these investigations had been carried as far as existing means of research would allow, we might then be able to trace a connection with those diseases which the consent of physicians assigns frequently, if not exclusively, to the use of contaminated drinking-waters.

It has been evident, I hope, from this statement that the permanent interests of preventive medicine have been kept in view from the outset of our work; and after five years of systematic observation and experience it is reasonable evidence that something of general value has been attained when a prudent Commonwealth is still willing to appropriate annually for the continuance of this work $27,000.

The first question that would undoubtedly be asked by any intelligent person upon looking over the long and wearisome tabulations of nitrates, nitrites, ammonias, and chlorine, not to mention the names of the grosser forms of microscopic life

and the innumerable bacteria, is this: How shall these figures and names be interpreted? This difficulty has always appeared so great that analysts have naturally enough fallen into the temptation of setting up so-called standards of purity, with numerical limits to the quantities of the various substances that may safely be present in a drinking-water. Even with these standards, it was very difficult to decide oftentimes what judgment to pass upon a water that approached very near to the permissible limits.

It was soon found that waters from different regions of the State could not properly be judged by one and the same standard, and that the results of the analyses of different classes of waters should not be placed in the same tables or otherwise directly compared with each other. It was ascertained, however, that waters collected from certain districts, when taken from unpolluted streams, ponds, or wells, did offer in one chemical constituent a very marked resemblance to each other; and if the various districts were arranged in a certain way, the variations of this substance were so constant as to permit of use in deciding from what portion of the State an unpolluted water came. This substance, always present, is common salt. As it is at the same time the invariable and imperishable evidence of the presence of the products of human life, its significance as a sanitary standard of purity is very great.

Upon a map of the State the places at which were found the same quantities of chlorine in waters obviously free from pollution were connected by lines. For convenience, such lines were called *isochlors*. These *isochlors*, representing successive differences of 0.05 part of chlorine in 100,000 of water, while near together and generally parallel in the eastern part of the State, correspond roughly to the coast line. Farther back from the ocean and toward the western limits of the State they are more widely separated and are not so noticeably parallel. The use that is made of the chart is this: when the chlorine in a given water agrees in amount with the

normal chlorine of the district, the water is assumed to be unpolluted; the excess of chlorine when found is taken as evidence of contamination. As a result of many hundreds of analyses, under conditions where the character of a water can be otherwise satisfactorily ascertained, the map has proved trustworthy, and the excess of chlorine stands in a very direct relation to the number of inhabitants on the water-shed. The Board felt justified in saying, as the result of a most careful study of all the data relating to the amount of chlorine contributed to sewage by each inhabitant per day, that four families of twenty persons per square mile will add, on an average, 0.01 of a part of chlorine per 100,000 of the water flowing from the area selected. There are, of course, certain limitations to be applied to the use that can at all times and places be made of the above chart, which my hearers will readily understand. I wish, however, to show that many thousand determinations of the waters of the State, with all the accuracy that the best laboratory methods can afford, have given our health authorities this convenient and trustworthy means of deciding upon the pollution of a water by sewage.

The discovery of such a standard could not have been fairly anticipated, and would not have been possible, without a body of statistics procured by thoroughly trained observers, and put to the test of exact laboratory methods of water-analysis.

Another peculiarity in the annual changes undergone by the water contained in deep reservoirs has also been explained through the careful study of the large collection of observations and chemical analyses now in our possession. These water-supplies have hitherto puzzled analysts by revealing upon examination in the late autumn and early winter amounts of nitrogenous matter excessive in quantity and of a quality generally considered to be especially threatening to health. Accurate observations of temperatures of the water taken at various depths in the month of July showed, in a pond of an area of 70 acres with a maximum depth of 57 feet, the following

results: the surface layer had a temperature of 74°—which was the average temperature of the ponds of the State; the water at the bottom of the pond had a temperature of 42°, or 32 degrees colder than the surface, and only 10 degrees above the freezing-point. As the bottom layers retained this degree of cold through the warm weather, there was evidently no appreciable amount of heat transmitted from the surface, and no circulation. In the case under consideration the low and generally constant temperature in summer below twenty feet shows that this lower body of water was beyond the influence of motions produced by winds or currents acting upon the surface—was therefore stagnant and not reached by the air. When the water grew colder, the water at the surface with a lower temperature became denser and denser, until a circulation was established down to the bottom of the pond. The variations in chemical analysis at varying depths are fully as remarkable as the changes in temperature. On the 18th of May, when circulation had ceased, the surface water contained no free ammonia, while the bottom layer had the large amount of 0.0800 per 100,000. On the 27th of November, when vertical circulation had been established down to the lowest depths, and the water was consequently of uniform quality throughout the pond, the free ammonia at the surface had risen from 0.0 to 0.0600 per 100,000, and was substantially uniform in amount throughout the whole body of water. All the resources of our laboratories, biological, chemical, and physical, were called into operation in the course of this investigation. It would not be profitable to here enumerate the details of them; let it suffice to say that no one method of examination, either of temperatures and specific gravities, or chemical or biological, would have given a satisfactory idea of the real conditions produced by the apparently simple operation of certain natural laws.

To thoroughly understand all the changes ordinarily undergone by a water-supply is an indispensable preparation for the study of the unusual occurrences which have so often disturbed

the comfort and health of large communities, and have almost invariably been found incapable of satisfactory explanation by the expert too tardily summoned to their investigation. With our own experience in mind, I may be permitted to say that every public water-supply should have the watchful oversight of some authority sufficiently well informed to be able to state definitely the dangers of its use.

Inasmuch as nearly all the water-supplies of Massachusetts depend upon water stored through the dry seasons of the year in order to provide a regular supply during times of drought, the question of the best plan for the construction of reservoirs is a very important one. From the experience which I have just now stated it is evident that the reservoir must not be so deep, for the storage of ordinary waters at least, that there may not be a thorough circulation in it at all seasons of the year. It is also apparent that some mechanical contrivance is desirable by which the bottom layers of water in a very deep reservoir might be allowed to run to waste during the months when these waters contain excessive amounts of nitrogenous matters. There are some other conditions of the reservoir which have a very important influence upon the waters contained in them. All the substances contained in the reservoir which are capable of bringing into contact with the water available nitrogenous material should be thoroughly removed; otherwise, troublesome vegetable and animal life may be expected to develop therein. While it is true that we have no satisfactory evidence that injury to health is caused by such growths, it is quite evident also that waters offensive to the senses will not be used, and that the usual recourse taken, in the case of offensive surface waters, to disused wells is a distinct source of danger.

Waters that are derived from sources below the surface of the ground, while generally free from organisms, cannot be safely stored in open reservoirs exposed to the light; in some instances such waters have been found, after storage, to contain microscopic organisms in excess even of those found in

any other source of water-supply. This apparent contradiction is explained by the fact, that as water contaminated by various nitrogenous matters sinks through the soil to lower levels, the organic substances are converted into inorganic material which supplies the nitrogen to support a new growth of organisms. In the iron-tank reservoirs, now so much used, a remedy is easily applied: a covering sufficient to cut off the light will prevent the deterioration of the water resulting from such growths. The water pest of Europe—*Crenothrix Kühniana*—though quite generally distributed in our surface waters, has not often given rise there to serious annoyance; but under conditions more favorable to its growth, the water infested by it has been rendered practically unfit for use. These necessary conditions are decomposing organic matter and iron in solution as protoxide, and are likely to exist in cases of rapid and imperfect filtration. We are, therefore, prepared to advise that certain waters will in all probability become affected by this pest, and so to warn against their use for public water-supplies, or if they are already in use and cannot be replaced, to suggest appropriate remedies.

The discussion of the best means for purifying water which has been contaminated by sewage is inseparable from the question of water-supplies for domestic use. A water-supply beyond the reach of pollution by human waste hardly exists anywhere; certainly our own large cities are constantly exposed to danger from this direction; it is, therefore, all-important to know what changes the polluting substances undergo on their way to the reservoirs or watercourses, and how these changes may be from time to time modified.

The essential elements of sewage are the organic matters therein. Sewage is, in a general way, water fouled by the mixture of less than one-fifth of one per cent. of foreign matters of organic and mineral origin. The sewage of Massachusetts cities yields, on an average, less than one-tenth of one per cent. of the organic matter, which gives to sewage its noxious influence in the production of disease and is the origin

of the more or less offensive sewer-gases which have played so conspicuous a part in popular sanitation. The mineral constituents, so far as the interests of health go, may generally be neglected.

For the purpose of studying all practicable methods for the purification of sewage there has been established upon an appropriate piece of ground in the city of Lawrence an experiment station with a small laboratory for chemical and biological investigations, and enough open ground adjoining the laboratory for the treatment of sewage by the different methods of irrigation. Large receptacles have been built so that diversified soils may be used, and arrangements have been made that permit the greatest accuracy of measurement of the quantities of the liquids applied to the surface and of the resulting effluent. It has for a long time been known that sewage could be satisfactorily purified by applying it in the way of broad irrigation to land occupied by growing crops, but the amount that can be so purified is comparatively small, and where the quantities of sewage used are excessive, the fields become offensive and the effluent waters dangerous to health if allowed to enter a water-supply. The conditions under which an experiment of this sort could be made profitable to a community are rare. When it was understood, however, that the destruction of nitrogenous matters was not the result of oxidation by the action of the air contained in the soil, but that the active presence of microscopic organisms was essential to the process of nitrification, then experiments were made in laboratories which showed some astonishing results in the quantities of sewage that could be purified by filtration. The results, however, were, as a whole, varying and unsatisfactory. The experiment station was, therefore, established for the purpose of determining the principles of filtration, and to learn what could be accomplished with filters made from the various soils found in the State in such localities that the soils might be profitably used for filtration areas. The conclusions to which we have come are the result of more elaborate experi-

ment and investigation than have before been bestowed upon this subject, and are, I believe, a safe foundation for future observations; as many of these results have already been published, further reference to them need not here be made.

Nitrification was first shown to be due to the action of certain microörganisms by Schloesing and Muntz in 1877; the precise nature of these organisms was not, however, satisfactorily determined by them; and it was not until very recent years that a real advance was made in the study of the nitrifying organism. In 1890, by similar methods, and at periods of time so nearly simultaneous that the investigations must be admitted to be independent of each other, the Franklands and Warrington in England, Winogradsky in Zürich, and Mrs. Richards and Mr. Jordan at Lawrence, announced the discovery of a microscopical organism capable of nitrifying, but not growing in the ordinary methods of gelatin plate culture. Peculiar difficulties in the way of an accurate study of this newly discovered bacillus exist on account of the unusual methods of cultivation required by it; it appears, however, to be almost universally present in surface waters and the upper layers of the soil, but the conditions most favorable to its growth will be a fit subject for the most elaborate and technical investigation.

Observations made on the filters at the Lawrence station had already taught us that rapid nitrification was always coincident with a marked diminution in the number of recognizable bacteria, so that the difficulties had already been presented of understanding how a process which we are convinced depends upon the active life of microörganisms should go on while the known bacteria were disappearing; in fact, the more complete the nitrification, the fewer were the bacteria in the effluent.

A brief statement of the nature of some of the investigations of the experiment station, contained in the unpublished report in my hand, will show the kind of work now doing at this laboratory:

WORK AT THE LAWRENCE EXPERIMENT STATION.

During the past year the investigations in regard to the purification of sewage and water have been continued along the same general lines as in previous years, but in such a way as to throw additional light upon numerous points of great practical importance. We have given special attention to determining the maximum quantities of sewage which can be satisfactorily purified by intermittent filtration under various conditions; to the care of the surface of filters, and to the methods of application of sewage; to the effect of severe winter weather; and to the treatment of acid sewage. The filtration of water has also received increased attention.

Most of the old filters described in earlier reports have been continued, while numerous new tanks have been started, to throw additional light upon special points connected with the purification of sewage and water.

Filter Tank No. 1, of coarse sand, has filtered in 1881 at an average rate of 102,000 gallons per acre daily for every day in the year. During the extremely cold winter weather the surface was unprotected from the cold, but snow was removed from the surface after each storm. Notwithstanding these unfavorable conditions, the extremely large quantity of sewage continually applied, and the fact that this same sand had been constantly in use, without change, for sewage filtration, for four years, since January, 1888, there was a removal of over 93 per cent. of all the organic matter of the sewage, as shown by the albuminoid ammonia; and of 97½ per cent. of the bacteria. This excellent result has been obtained with a greatly increased volume of sewage—64 per cent. larger than the previous year, when the average rate was 62,000 gallons per acre daily, with a removal of 95 per cent. of the albuminoid ammonia and 97 per cent. of the bacteria. The ability to purify this increased quantity is mainly due to systematically disturbing the surface, which was commenced in 1890 and mentioned in the last report.

Filter Tank No. 2, of very fine sand, was also exposed to severe winter weather, and yielded good results, with the large quantity of 60,000 gallons per acre daily. In the summer, however, this proved to be a larger quantity than could be maintained; the upper layer became choked, and air was thereby excluded, until in August the quantity applied was reduced to 42,800 gallons per acre daily. Following this the operation of the filter rapidly improved, the average analysis of the effluent for the last two months, November and December, being as follows:

	Parts per 100,000.
Free ammonia	0.0058
Albuminoid ammonia	0.0098
Chlorine	7.46
Nitrogen as nitrates	1.71
Nitrogen as nitrites	0.0004
Oxygen consumed	0.08
Bacteria contained in one cubic centimetre	9.

For the entire year, including the severe weather in which the surface was unprotected, and the period of overdosing with exclusion of air, the average quantity of sewage passed was at the rate of 46,000 gallons per acre daily for every day in the year; and, of the organic matter of the sewage, 96 per cent. was removed, and 99.98 per cent. of the bacteria—practically their complete exclusion.

Filter Tank No. 16: Commencing November 29, 1890, sewage was applied to this tank of small, clean stones in small doses, every half-hour, days, nights, and Sundays. During the following eight months the quantity of sewage applied was at the rate of 200,000 gallons per acre daily, and 94 per cent. of the albuminoid ammonia and 97 per cent. of the bacteria of the applied sewage were removed. This was a most satisfactory result, but the quantity was greater than could be permanently maintained; for in the last of July the organic matters stored from the sewage had so increased that air was excluded and nitrification stopped. Since that time the quan-

tity applied has been reduced, but the old standard of purity of effluent has not been again reached.

On the Effect of Frost.—During the past winter the outdoor filters were exposed without protection to the weather. The snow was removed after each storm. With the more open materials there is sufficient air-space, even when frozen, to allow the passage of sewage, which, when applied at the sewer temperature of 44° to 46°, thaws to some extent the frost. The finer materials, where the sewage stands for a time on the surface, in very cold weather freeze solidly, when completely saturated with water in their upper layers; and in these cases the application of more sewage is impossible until holes have been made through the saturated layer to the more open sand below. By promptly removing the snow, and making holes through the frost when necessary in the finer materials, we succeeded in each case in applying all, or very nearly all, the sewage which it was desired to use. The results obtained were less perfect than those of warmer weather; the effluent in each case containing during the worst three months approximately three times as much organic matter as under comparable conditions in summer.

During this period of least complete purification there was removed from the sewage:

	Albuminoid ammonia. Per cent.	Bacteria. Per cent.
Tank No. 1, very coarse sand	84	93
Tank No. 6, coarse sand	92	95
Tank No. 2, fine sand	95	99.92
Tank No. 4, very fine sand	95	99.98

A careful study showed that if any bacteria passed Tank No. 8, the number must be very small—at least as low as one in a thousand. The best proof that none pass was given by applying water taken from the canal, instead of the city water, commencing November 13, 1891. The city water, which had been applied during the four years in which this filter had been in use, is taken from the Merrimac River, but,

in passing through the capacious reservoir and some miles of pipe, requiring in all probably two weeks from the river to the experiment station, the greater number of bacteria die. While the city water had about a hundred bacteria per cubic centimetre, the canal water, which is taken from the Merrimac River, above Lawrence, contained from one thousand to ten thousand. If the small number of bacteria found in the effluent of Tank No. 8 had come through the filter, we should have expected that, on applying the canal water, the number would have increased in somewhat the same ratio as the increase in the numbers applied. The actual result, however, was that no more—in fact, hardly as many—were found after making the change.

The average number of bacteria for six weeks, from November 15 to December 26, was as follows:

Applied water	2989
Effluent	0.91

showing a removal of 99.97 per cent., with great probability that those which occasionally appear are due to accidental contamination, or grow in the underdrains.

The one objection to the application of filters like this to the purification of water on a large scale is the low rate of filtration. Up to the end of the second year the filter easily took sewage at the rate of 257,000 gallons per acre daily. During the third year the material became a little clogged, and the quantity passed fell off slightly, and in the fourth year the quantity filtered has only been at the average rate of 183,000 gallons per acre daily.

Tank 18 A, of No. 1 sand, also filtering canal water, but at a rate of a million gallons per acre daily, has at times removed a very large percentage of the bacteria, the result for two weeks, December 7 to December 20, being—

Applied water	4800
Effluent	15

showing a removal of 99.7 per cent. The results have been, however, somewhat variable, and it does not seem probable that a filter of so coarse material could be so managed as to always secure the removal of objectionable germs from sewage-polluted water. It does seem probable, however, that filters can be constructed of material in size somewhere between that of No. 8 and of No. 18, which will allow the passage of more water than No. 8, and at the same time secure the removal of all pathogenic germs. We have started four new filters, to determine what can be done in this direction. Two of them are used for intermittent, two for continuous, filtration. On one of each, continuous and intermittent, the specific germs of typhoid fever will be applied, to determine more definitely the conditions of their removal by filtration.

We had occasion—in connection with an unusually high death-rate from typhoid fever in the cities of Lowell and Lawrence, both situated along the banks of the Merrimac River and making use of its waters as a source of domestic supply—to call the attention of the authorities to the dangers of drinking water polluted by sewage, even though the degree of pollution be very slight. All the cities of the Commonwealth for the twelve years 1878–1889 had an average annual death-rate from typhoid fever of 4.62 per 10,000 living; the two cities above mentioned had respectively ratios per 10,000 of 7.63 and 8.33, the city lying lower down the river having the higher death-rate just as she had a more polluted water-supply. In the year 1890 this disease became a real epidemic in the two cities, and not elsewhere in the State. Our registration reports show this very plainly. The death-rate from typhoid fever throughout the State in the year 1890 was 3.7 per 10,000 living. If these two cities had only as many deaths relatively from this disease as all the cities of the State had, the number would have been 36 in Lowell and 21 in Lawrence, and not 150 in Lowell and 78 in Lawrence, the number actually recorded. How serious a burden the occurrence of the fever must have inflicted upon these populations, beyond

that borne by the inhabitants of the other cities, can be easily understood. Careful inspection of the banks of the river above Lowell gave satisfactory evidence of direct pollution of the stream by the exereta of persons sick with typhoid fever. Though there was nothing in the waters of this large river to suggest to any one of our senses the fact of this pollution, and though chemical analysis alone did not condemn the water, it was too evident by a crucial test upon the living body of man that something had been added to the water above the intake of the Lowell supply which produced a certain disease in that city, and that Lowell, in turn, reproduced the same disease in Lawrence, nine miles lower down the stream. Repeated examinations of the water supplied to the two cities were made by competent observers, but the organism now generally assumed to be specific to typhoid fever—the bacillus of Eberth—was not detected with certainty in more than one of the cultures. We have experienced all the difficulties which other observers have felt in our attempts to distinguish this bacillus from the great number of similar bacteria always present in natural waters. Quite recently, however, a much greater degree of confidence has been felt by those specially charged with the bacterial examinations in their ability to recognize this microörganism, and largely by a better experimental knowledge of its physiology.

Many experiments have been made and are still going on to determine the life history of the bacillus of Eberth in milk, water, and sewage, and upon the possibility of its passage through the filters.

While it is generally conceded that typhoid fever results from a specific and now identified bacillus, there are still many questions with regard to the epidemic prevalence of this disease at certain times and places which we cannot answer. More than one instance in the past year of an outbreak of typhoid fever in a town or public institution has been as carefully investigated as the abundant resources at our disposal would allow, and yet we have not discovered a satisfactory

cause. In certain other cases—Lowell and Lawrence, for instance—there seemed no reasonable doubt as to the origin of the disease and the manner of its extension. The registration reports of the State of Massachusetts are worthless for nearly twenty of the earlier years, so far as a discrimination of the cases of typhoid fever is concerned. Is it certain that a still greater accuracy of diagnosis may not again separate into several distinct diseases the class now designated as typhoid or enteric fever? But whatever disposal of the cases of the disease now called typhoid fever we may make, so far as their arrangement in our nosologies is concerned, there will remain too many which can be and ought to be prevented. How many years ago was it that Benjamin Rush said: "The means of preventing pestilential fevers are as much under the power of human reason and industry as the means for preventing the evils of lightning or common fire. I am so satisfied of the truth of this opinion that I look for the time when our courts of law shall punish cities and villages for permitting any of the sources of bilious and malignant fevers to exist within their jurisdiction."

The State Board of Health of Massachusetts has investigated many questions of great public importance, either by direction of the Legislature or in order to more intelligently enforce the various statutes of which the Board itself is the responsible guardian. Some of these investigations have been of the kind that could not be carried on without the best expert assistance and well-equipped laboratories. One report to the State, which showed the great danger in the use of illuminating gases containing a high percentage of carbonic oxide, would have effected a saving of many human lives if it had not been met by the seemingly irresistible power which associated wealth, backed by hired professional experts, can bring to bear upon public bodies. It has carried on for many years a painstaking and, it believes, scientific study of the influence of arsenic in wall-papers and fabrics, and the manner in which this influence is exercised. While it is as certain

as anything in medical observation can be, that a peculiar complex of symptoms accompanies the demonstrated presence of arsenic in the excretions of the human body and disappears with the gradual elimination of the arsenic so found, and that these conditions are discovered to exist where arsenic is also present in the wall-papers or fabrics surrounding the individual affected, it is also true that, as yet, no satisfactory proof has been given of the form in which the poison enters the system. Upon this question much time and labor have been spent, not only in this country, but in foreign laboratories. A recent announcement in the publications of the scientific laboratories of the Bureau of Health of Italy of certain investigations by Dr. Gosio again bring forward the suggestion made a number of years since by Selmi, that poisonous gases of arsenic are probably produced by the action of microphytes upon certain stable compounds of this metal. Selmi, however, failed to establish his hypothesis by experiment. Dr. Gosio claims that his own investigations have demonstrated beyond question that the common mould, *Mucor mucedo*, will tolerate the presence of considerable quantities of arsenic, not only without injury, but with positive advantage to its growth; that many fixed compounds of arsenic are transformed into gaseous combinations by the vital activity of certain fungi. This transformation has been experimentally demonstrated for all the oxygen compounds of arsenic, including the arsenite of copper. It has not, however, as yet been shown to be true of the sulphur compounds of arsenic. Fabrics colored with Scheele's green or Paris green evolve arsenical gases under certain conditions of moisture, temperature, and light, through the influence of the growth of *Mucor mucedo*.

These observations evidently deserve attention, and should be subjected to the rigorous examination of disinterested experts.

Questions have also arisen with regard to the presence of other metals—copper and tin—in articles of food, the addition

of these metals serving no useful purpose except an improvement in appearance of the food-product so treated. This treatment may be simply a recognition of the demand of the consumer for certain colors which are more agreeable to the eye, because in the case of artificially greened vegetables there is the suggestion of a freshness which belongs only to nature. It may be a commercial fraud for the purpose of making a damaged article appear better than it really is. If there arises from this coloring a real danger to health the process should not be permitted to go on. Sulphate of copper, the agent used for this process of greening, is, we shall probably all admit, a poisonous substance which ought not to be used in articles of food by irresponsible persons and without fixed limits.

In 1878, M. Bussy, in the name of a commission of those appointed by the Comité Consultatif d'Hygiène of France, at the request of the Minister of Agriculture, made a report recommending that the process of re-greening vegetables by salts of copper be forbidden. In the same year, M. Pasteur, while not believing the salts of copper to be so injurious as had been thought, recommended that their use should be forbidden unless the boxes containing vegetables so treated were marked "greened with copper." In a few years, however, a great change came over the minds of the French sanitary authorities. The industry for preparing for the market preserved pease and similar products employs in France 20,000 persons and represents a business of forty million francs. Such powerful business interests made themselves felt, and France gives us no protection to-day against the unlimited introduction into a food-stuff of an unnecessary and, in some quantities, not yet ascertained, harmful coloring matter. As these French pease are used more especially in the season of our own fresh pease, it would seem but just that the home product should have more satisfactory protection.

I have told the story of this article of food because it illustrates very well the opposition which any attempt to protect

the public health will encounter whenever large private interests believe themselves to be in danger. It will then be found that a great business concern employs the most skilled and learned advocates, procures the service of the highest-priced man of science, and often wins in the contest. The real sufferer from the adulterations of foods and drugs, from noxious gases, or from injurious trades rarely reaches the presence of the law-makers; no hired advocate presents his cause; no expert comes from hundreds of miles away to place at his disposal all the scientific knowledge of the day. The sole hope of the plain people rests in the knowledge possessed by institutes of hygiene, however they may be named, made available through competent public health authorities. The acceptance by the people of scientific teaching, and the experiences which have verified it are hopeful indications of the growing power of disinterested sanitary protection. For the improvement of sanitary institutions we must look to the medical profession and schools of medical teaching, and the verdict they may render of success or failure must needs be final.

In this city lived and labored the most famous physician of our land. The words in which he at once conveyed a warning and set forth the real lesson of his own illustrious life are equally appropriate to a school of research.

"That physician has lived to little purpose who does not leave his profession in a more improved state than that in which he found it. . . . Let no useful fact, therefore, however inconsiderable it may appear, be kept back from the public eye; for there are mites in science as well as in charity, and the remote consequences of both are often alike important and beneficial. Facts are the morality of medicine; they are the same in all countries and throughout all times."

I have endeavored to present in the remarks to which you have so kindly given your attention some of the evidences that public health authorities must take cognizance of all that the laboratories of hygiene are doing. A board of sanitary

control has no higher duty than that of educating itself in all the scientific knowledge of all that pertains to the preservation of the public health. If it proposes to give advice upon the best methods of disinfection, of controlling the spread of communicable diseases, of the purification of sewage and the conservation of water-supplies, and of preventing disease, it must do so upon the most accurate information attainable.

The exercise of the ordinary functions entrusted to sanitary authorities constantly brings forward not only new questions, but also different conditions of the old problems; and we must never lose the just confidence that our exact knowledge in sanitary science will inevitably find its useful applications.

Preventive medicine will always have need of continued and combined scientific inquiries by the most refined methods of laboratory investigation, and we shall ever be on the watch to recognize and adapt to our own public service the acquisitions of this latest and most carefully prepared Laboratory of Hygiene.

LABORATORY OF HYGIENE,

UNIVERSITY OF PENNSYLVANIA,

THIRTY-FOURTH AND LOCUST STS., PHILADELPHIA, PA.

STAFF OF THE LABORATORY.

Director.—JOHN S. BILLINGS, M.D., U. S. Army.
First Assistant.—A. C. ABBOTT, M.D.
Assistant in Bacteriology.—ALBERT A. GHRISKEY, M.D.
Assistant in Chemistry.—HILL SLOANE WARWICK, M.D., Ph.D.

COURSES OF INSTRUCTION IN THE LABORATORY.

On February 1, 1892, the Laboratory was opened for students desiring instruction in the following courses.

I. A COURSE IN PRACTICAL HYGIENE,

comprising lectures and practical work in the Laboratory upon the following subjects:

1. Water. Physical, chemical, and bacteriological investigation of water-supplies; methods of obtaining samples; qualitative and quantitative analysis for impurities; collection, storage, and purification of water intended for domestic use; effects of filters, aëration, etc.
2. Disposal of refuse, cremation of garbage, etc.
3. Sewage disposal, sewers, and house-drainage.
4. Soils and building-sites, physical, chemical, and bacteriological investigations, soil-moisture, ground air.
5. The atmosphere, climate, and meteorological observations and records, chemical analysis, bacteriological investigation, methods of ventilation and heating.

6. Foods—adulterations, milk and meat inspection.

7. Clothing—microscopic examination, poisonous dyes.

8. Lighting—gas, electricity, illuminating oils.

9. Management of contagious diseases. Practical tests of different methods of disinfection, chemical and thermal; notification, isolation, and quarantine.

10. Vital statistics, registration, and methods of tabulation.

11. Offensive and dangerous trades.

12. Sanitary jurisprudence, law of nuisances, duties of health officers, etc. The above course of instruction will occupy eight weeks, five days a week, from 9 A.M. to 12 M. The Laboratory is open until 5 P.M. for those students in this course who wish to continue work in the afternoon. A special examination will be held at the end of the course for those students who wish to obtain a certificate of qualification to perform the duties of health officer.

Only those students who give evidence of fitness to profit by the course will be received. It is very desirable that students should have some practical knowledge of chemical manipulation and of the use of the microscope.

The fee for this course will be $50, payable in advance. A deposit of $25 will also be required as a guarantee fund, from which will be paid the cost of apparatus broken or lost by the student. The necessary apparatus will be furnished free of charge, but must be receipted for, and any loss or damage made good. The ordinary chemicals will be furnished free of charge, but materials for bacteriological investigations must be purchased by the student. They can be obtained from the janitor of the Laboratory.

II. An Elementary Course in Bacteriology,

to continue eight weeks, five days a week. This course will cover the following subjects:

1. Apparatus employed—sterilizers, incubators, pressure regulators, thermostats, etc.

2. Culture media, methods of preparation, sterilization methods.

3. Microscopic characteristics of cultures of bacteria in general, and of special forms.

4. Methods of obtaining from mixtures of different bacteria individual species in pure cultures.

5. Microscopic technique. Use and care of instruments, staining from cultures, section cutting, and staining and mounting of tissues.

6. Pathogenic bacteria, isolation, identification, and inoculation.

7. Immunity, preventive inoculations, and preparation of vaccines.

8. Disinfection, thermal and chemical, methods and apparatus, modes of testing efficiency.

9. Antisepsis and asepsis in surgery and obstetrics, preparation of dressings, instruments, operator, and assistants, and of patients.

10. Bacteriological investigation of water.

11. Bacteriological investigation of air.

12. Bacteriological investigation of soil.

The fee for this course will be $25, payable in advance.

An advanced course in Bacteriology will be given, commencing April 2d, and continuing eight weeks, five days per week. It will include special researches adapted to each student.

The fee for this course will be $25, payable in advance.

Other courses will be announced hereafter.

Applications for admission to any of the above courses should be addressed to

Dr. A. C. ABBOTT,

Laboratory of Hygiene,

University of Pennsylvania,

Thirty-fourth and Locust Sts., Philadelphia, Pa.

THE THOMAS A. SCOTT FELLOWSHIP

IN THE INSTITUTE OF HYGIENE OF THE UNIVERSITY OF PENNSYLVANIA.

SINCE the opening of the Institute this Fellowship has been founded and generously endowed by Mrs. Scott as a memorial of the late Thomas A. Scott, Esq., of Philadelphia. Its object is to aid young men of talent who desire to become investigators or teachers in the field of sanitary science and to promote the increase of knowledge in that department.

The power of appointment to this Fellowship rests with the Board of Trustees of the University, who will act upon recommendation made to it by the *Electors to the Fellowship*, comprising the Provost of the University, the Chairman of the Committee of the Board of Trustees of the Institute of Hygiene, and the Director of the Institute.

The salary attached to the position is the income arising from $10,000, the amount of endowment of the Fellowship.